Original Research Article

Air Dried Instant Noodle from Banana Peel Powder (Pisang Nangka [*Musa x paradisiaca*])

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Abstract: This study addresses the high global demand for bananas, particularly in small and medium-scale industries that process banana-based foods in Malaysia, which contributes to a significant amount of food waste. The primary goal of this research is to formulate a high fiber air-dried instant noodle by incorporating banana peel powder. Through textural, proximate, and sensory analyses, the study investigates the impact of banana peel powder on instant noodle quality. Four samples were analyzed: a control sample (wheat flour-based), Sample A (10% wheat flour substituted with banana peel powder from stage 3 ripeness), Sample B (10% substitution with banana peel powder from stage 5 ripeness), and a premium sample (with activated charcoal). The texture research reveals that the addition of banana peel powder has a significant effect on the noodle's hardness, chewiness and cohesiveness Results show that banana peel powder notably enhances the total dietary fiber content, with Sample B exhibiting the best overall sensory performance. The findings underscore banana peel's potential as a functional ingredient to reduce food waste and improve the nutritional and sensory qualities of instant noodles.

1. Introduction

The type of banana that was selected to produce the banana peel powder in this research is *pisang nangka* (*Musa x paradisiaca*). This is because this type of banana is unfamiliar in past research. In contrast, there are several research projects that already show the results by using the peel in other varieties of banana to produce banana peel powder and the varieties of food products. For example, development of banana peel jelly by using Cavendish banana (Lee *et al.*, 2010), the role of banana peel powder in the nutritional quality and sensory of

chicken sausage by *Musa balbisiana* (Plaintain) (Mohd Zaini, *et al.*, 2021) and pasta and bakery products from Banana Cavendish (Segura-Badilla, *et al.*, 2022).

Normally, instant noodles contain flour, salt and palm oil as their main raw ingredient. This type of noodle can be said to be one of the most famous and common types of ready-to-eat meals that can be found in many parts of the world due to their not expensive and easy to prepare characteristics. Nevertheless, instant noodles also have properties like low fiber, protein and high in fat or carbohydrates. These properties of instant noodles may cause some health problems such as heart disease, metabolic syndrome, high blood pressure, obesity and diabetes. According to World Instant Noodles Association (WINA), the global demand for instant noodles was 117 billion servings in the year 2020, and nearly 1.35% of this consumption came from Malaysia (Koh *et al.*, 2022). From here, it can be known that instant noodles for Malaysians are irreplaceable. Hence, it is important to find a method which can overcome their disadvantages and at the same time can maintain their deliciousness.

In this study, the banana peel from jackfruit banana will be selected to use as the raw ingredient to make the instant noodle. By adding the banana peel powder into the instant noodles, a beneficial chemical reaction occurs, enhancing the proximate composition of the noodles. This transformation elevates the nutritional value, particularly by increasing the fiber content, thereby making the noodles healthier.

## 2. Materials and Methods

2.1. Materials

The main materials that needed to be involved in this project were *pisang nangka* peel, wheat flour and salt. The *pisang nangka* was obtained from the farm located at Sungai Ruan, Raub, Pahang and the online store in Lazada named Metrostatik Grocer. For the ingredient used to make the noodle, they were purchased from the TF and TMG supermarket in Raub, Pahang.

2.2. Preparation of Banana Peel Powder (BPP)

To produce banana peel powder, jackfruit bananas (*pisang nangka*) were used at two different ripeness stages (Stage 3 and Stage 5). Ripeness stages significantly impact the composition of the peel due to enzymatic activity. At Stage 3, bananas have a higher starch content, and the peel is thicker, while at Stage 5, enzymatic hydrolysis converts starch into sugars, leading to a thinner peel with potentially different fiber composition. Additionally,

polyphenol oxidase activity increases at Stage 5, contributing to changes in color and antioxidant content. These differences may influence the final texture, nutritional value, and sensory attributes of the noodles.

The bananas were divided into 2 groups; the first group was peeled off when they were Stage 3 and another group was peeled off when Stage 5. After the peel was collected, all the peel needed to be washed by using water carefully to ensure that the peel was in a clean condition without the dirt or dust on the surface of the peel. After the washing process, the banana peels were immersed into 0.5% citric acid to prevent the enzymatic browning happening and cut into smaller sizes to speed up the drying process to make sure all the banana peels can be dried completely during the drying process. The small size banana peels were then arranged on the oven tray prepared to dry in the oven. After that, the tray with banana peel was put into the oven and dried in 60°C for 24 hours to 72 hours, or until the banana peel dried. Next, the pieces of dried bananas were ground using a blender and then passed through a sieve shaker (Retsch) to filter out the granule dried banana peel. Finally, the banana peel powder was stored in an airtight polyethylene bag at room temperature and is ready to use for future experiment.
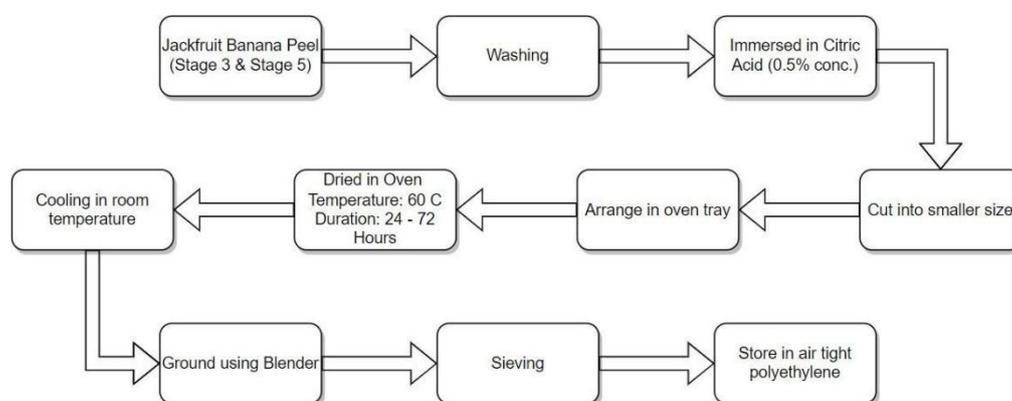
Figure 1. Procedure to make Banana Peel Powder.

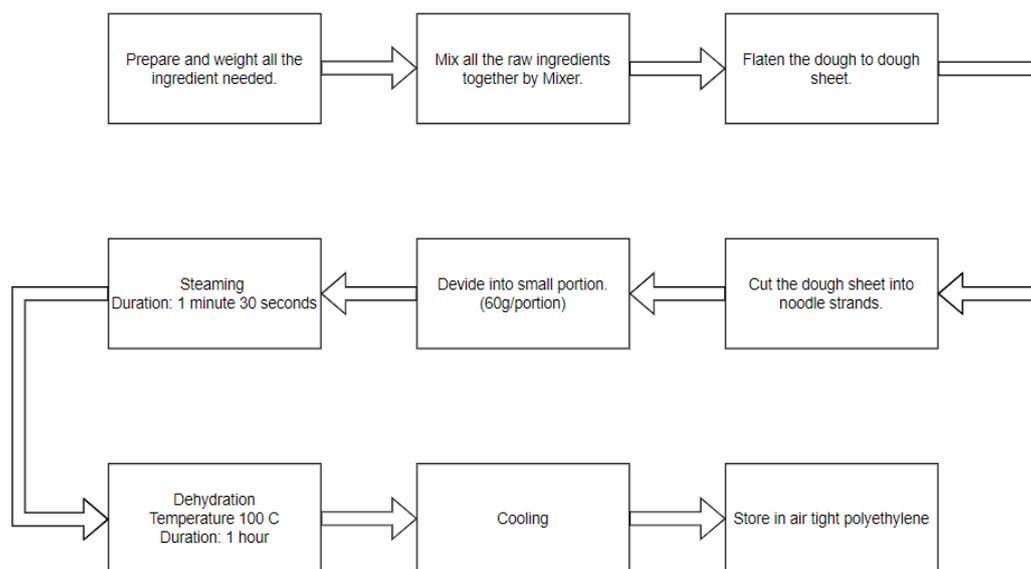## 2.3. Preparation of Air-Dried Instant Noodle

Two samples of noodles were produced by replacing 10% wheat flour with Stage 3 and Stage 5 banana peel powder. The first step in the procedure is the preparation of raw ingredients. In the noodle making process, the ingredients needed are wheat flour, water, salt and banana peel. First, the banana peel powder was mixed homogeneously with the wheat flour using a mixer, while the salt was mixed and dissolved in water at room temperature. After the mixing process, all the salt water gradually added to the mixed flour until the dough formed without sticking to the mixer bowl. The mixer was set to low speed first for 5 minutes

and set to high speed for 5 minutes. After that, the dough was flattened into sheets by using a roller in the noodle-making machine. The thickness was first set to 7, followed by level 5 and finally level 3. After the dough sheet forms, the dough sheet will be passed through the slitter, completing the fresh noodles and ready for steaming. The noodles were divided into small portions with 60 g per portion and arranged carefully on the tray. The tray of noodles underwent a steaming process for 1 minute 30 seconds. Then, the steamed noodles were dehydrated in the oven for 1 hour at 100˚C. After the dehydrating process was complete, the noodles were taken out from the oven and cooled at room temperature. Finally, the air-dried instant noodles were stored in a food grade airtight polyethylene bag at room temperature and until the next experiment.

In this research project, four noodle samples were prepared: a control sample (0% banana peel powder), Sample A (10% BPP from Stage 3 ripeness), Sample B (10% BPP from Stage 5 ripeness), and a premium sample formulated with activated charcoal. The inclusion of the premium noodle sample containing activated charcoal served as a comparative benchmark for evaluating the nutritional and functional improvements brought by banana peel powder. Activated charcoal is widely used in premium food products due to its proposed detoxifying properties and is often perceived as a health-enhancing additive in the commercial market. By including this formulation, the study aimed to assess whether banana peel sustainable, low-cost agricultural by-product can provide similar or improved nutritional value compared to higher-cost functional additives like activated charcoal. This comparison also supports the objective of promoting food waste valorization through innovative functional food development.

Table 1. Formulas for the sample noodles (Adopted from Vit Makanan (K.L.) Sdn Bhd).

Ingredients	Amount of the Ingredient (%)		
	Control	Sample A (Stage 3)	Sample B (Stage 5)
Banana Peel Powder	0	6.6	6.6
Wheat Flour	66.1	59.5	59.5
Water	33.0	33.0	33.0
Salt	0.9	0.9	0.9
Total	**100**	**100**	**100**

Figure 2. Procedure to make Air Dried Instant Noodle

2.4. Proximate Analysis

Proximate analysis is an experiment used to analyze the chemical composition of a material. Generally, this analysis involves the measurement of moisture content, ash content, protein content, fat content and carbohydrate content. In this case, the experiment of total dietary fiber content was calculated as part of the proximate analysis to indicate that the replacement of banana peel powder inside the instant noodle can help to increase the fiber content of the noodle.

2.4.1. Moisture content

The moisture content of the noodle was measured by using the moisture analyzer (XM50, Precisa). The air-dried noodle samples were crushed by using the rubber block and the small, crushed noodles were blended using the blender (MX-GM 1011, Panasonic) until the noodles became in powder form. Next, 2 g of noodle powder was put and measured on the petri dish by using the moisture analyzer. After that, the analyzer was run, and the results were recorded. The experiment was repeated at least 3 times, and the average value was calculated.

2.4.2. Ash content

To determine the ash content in the sample, 5 g of the sample was prepared and put inside the muffle furnace for 24 hours at the extremely high temperature which is 550˚C. The weight of the empty crucible and crucible with sample was measured before and after the

ignition by using the weighing scale. The following formulae were used to calculate the ash content.

Weight of ash (g) = [Weight of crucible + lid + ash(g)] − [Weight of crucible + lid(g)]

Ash Content (%) = (Weight of ash (g)/ *Total weight of the sample* (g)) x 100%   (1)

2.4.3. Protein content

The protein content can be analysed by using the Kjeldahl Method. This experiment was used to determine the nitrogen content, so that the protein content can be calculated based on the nitrogen value. First, the sample underwent the digestion process by adding sulphuric acid into the sample with Kjeltabs as catalyst. Next, the distillation process was carried out by adding boric acid, indicator and NaOH. Finally, the solution was titrated by using HCl. The titration was complete when the colour of the solution changed from green to pink. The volume of HCl is used in the formula below to calculate the protein content.

$$\text{Protein Content } (\%) = ((A - B) \times N \times Da \times X / W) \; x100\% \tag{2}$$

Where:

A = Volume of 0.20 N HCl used in sample titration (ml)

B = Volume of 0.20 N HCI used in blank titration (ml)

N = Normality of HCl

Da = Atomic weight of nitrogen (u)

X = Conversion factor of protein to nitrogen for noodle

W = Weight of sample (g)

2.4.4. Fat content

The Soxhlet extraction method was used to determine the fat content inside the noodle sample. The hexane solution was used as the solvent in the experiment due to its low boiling point properties. The weight of the empty test tube and weight of the test tube with the sample after the experiment was measured by using a weighing scale.

$$\text{Fat Content } (\%) = ((w_2 - w_{1)}/w) \times 100\% \tag{3}$$

Where:

w_2 = Weight of empty test tube (g)

w_1 = Weight of test tube with sample after the experiment (g)

w = Total weight of the sample (g)

2.4.5. Carbohydrate content

After completing the experiment above, the content of carbohydrates can be calculated by subtracting the total weight of the sample with the content of ash, moisture, protein and fat.

Carbohydrate Content (%) = Total weight of sample (g) − Total weight for moisture, ash, fat and protein of the sample (g)

(4)

2.4.6. Dietary fiber content

The determination of total dietary fiber content of noodle was measured by using enzymatic-gravimetric method. Soluble and insoluble fibre are measured separately using this approach. A portion of the sample was autoclaved, heat-stable amylase is added, and the mixture was filtered to determine the amount of soluble fiber. To remove starch and protein, amyloglucosidase and protease are added. The filtrate's soluble fibre was then precipitated by ethanol and filtered. A part of the sample was refluxed with neutral detergent to assess the amount of insoluble fibre. The α-amylase from porcine pancreas was used to treat the residue in order to eliminate protein and water-soluble carbohydrates. The residue was dried, weighed, ashed, and reweighed for each determination. The two residues together make up total dietary fiber as the formulae below.

$$Total\ Dietary\ Fiber\ (\%) = (C_{2r} - C_{2a} / S_2 + C_{1r} - C_{1a} - B / S_1) \times 100 \qquad (5)$$

Where:
Blank (B) = Cb – Ca
Cb = Weight of crucible with blank
Ca = Weight of crucible with blank after ashing
C1r = Weight of crucible with residue (Soluble Fiber)
C1a = Weight of crucible with residue after ashing (Soluble Fiber) C2r = Weight of crucible with residue (Insoluble Fiber)
C2a = Weight of crucible with residue after ashing (Insoluble Fiber) S1 and S2 = Weights of dry samples

3. Results and Discussions

3.1. Weight of Banana Fruits and Peel

Table 2 shows that there is a correlation between the ripeness of bananas and the thickness of their peel. Bananas at Stage 3 of maturity, represented by Sample A, had an average peel percentage of 31.77%. In contrast, sample B which is representative of bananas at Stage 5 of ripeness, had an average peel percentage of 26.47%. This suggests that more ripen bananas have thinner peels.

Table 2. The ratio of banana peel and unpeel banana in stage 3 & 5 ripeness.

Sample		Weight Unpeel Fruits	Weight Of Peels	Ratio Of Peel to Unpeel Fruit (%)
A (Stage 3)	1	68.00	20.00	29.41
	2	71.00	22.00	30.99
	3	56.00	19.00	33.93
	4	58.00	20.00	34.48
	5	60.00	21.00	35.00
	6	88.00	26.00	29.55
	7	121.00	41.00	33.88
	8	69.00	21.00	30.43
	9	64.00	23.00	35.94
	10	79.00	19.00	24.05
Average Percentage of Banana Peel A (Stage 3)				31.77 ± 3.60
B (Stage 5)	1	104.00	28.00	26.92
	2	109.00	28.00	25.69
	3	115.00	30.00	26.09
	4	86.00	22.00	25.58
	5	70.00	18.00	25.71
	6	87.00	22.00	25.29
	7	82.00	23.00	28.05
	8	61.00	17.00	27.87
	9	114.00	29.00	25.44
	10	114.00	32.00	28.07
Average Percentage of Banana Peel B (Stage 5)				26.47 ± 1.14

3.2 Proximate Analysis

Proximate analysis (Figure 3) was conducted on four noodle formulations: Control, Sample A (Stage 3 ripe banana peel powder), Sample B (Stage 5 ripeness), and Premium (with activated charcoal). This analysis evaluates key nutritional parameters, including moisture, ash, protein, fat, carbohydrate, and dietary fiber content, providing insights into the functional and nutritional effects of banana peel powder incorporation.
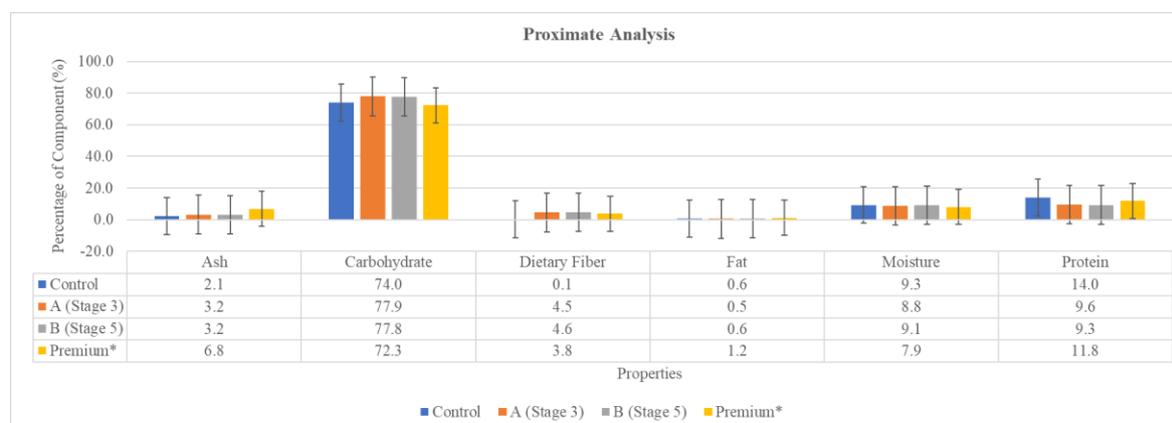
Figure 3. Proximate Analysis of noodle Control, Sample A, Sample B and Premium.

3.2.1. Moisture content

Analysing a product's moisture content is crucial in the food industry since it reveals important details about the amount of water it contains. This will impact food quality, stability, and preservation. Duta *et al.* (2019) state that knowing the moisture content of the food product can help to ensure the quality of the food item and decide the storage methods. Therefore, the food wastages problem due to the mishandling problem can be solved. The moisture content of four samples in this project was Control, Sample A, Sample B, and Premium. From Table 3, the moisture content of noodles ranged between 7.9% and 9.3%, with the premium sample showing the lowest value. Stage 5 bananas have more moisture than Stage 3 because the ripening process breaks starch into sugars (which hold water), and softens cell walls, releasing water into the pulp This variation may be due to the hygroscopic nature of banana peel fiber, which affects water retention. This increased sugar concentration in Stage 5 bananas make the powder absorb and holds more water when mixed into the noodle dough. As observed in Table 2, Stage 5 bananas have thinner peel compared to Stage 3 (26.47% vs. 31.77%). The thinner, more degraded peel structure at Stage 5 allows for easier water absorption and retention. This can be attributed to physiological changes during ripening: the conversion of starch into simple sugars like glucose and fructose (Terra *et al.*, 1983) increases the hygroscopic nature of the banana peel. Additionally, enzymatic softening of the peel enhances water retention. Conversely, the Premium sample had lower moisture, possibly due to the hydrophobic nature of activated charcoal.

Table 3. Moisture content of the samples.

No	Samples	Moisture Content (%)
1	Control	9.3
2	A (Stage 3)	8.8
3	B (Stage 5)	9.1
4	Premium	7.9

3.2.2. Ash content

The purpose of ash content analysis in the food industry is to Provide the information regarding the mineral content present in a food product. It determines the overall number of inorganic materials, which includes things like minerals, that are present in the sample.

During this experiment using proximate analysis, four samples were examined which were Control, Sample A, Sample B, and Premium, each of which had their own unique ash content values based on the results obtained. The addition of banana peel powder (BPP) significantly enhanced mineral content. Banana peels are rich in potassium, calcium, magnesium, and other trace minerals (Bakar *et al.*, 2018). Both Sample A and B exhibited an identical ash content of 3.2%, demonstrating that ripeness stage did not significantly affect mineral concentration. The Premium sample, containing charcoal, had the highest ash content due to the inorganic nature of activated carbon, which contributes to the total residue after combustion.

Table 4. Ash content of the samples.

No	Samples	Ash Content (%)
1	Control	2.1
2	A (Stage 3)	3.2
3	B (Stage 5)	3.2
4	Premium	6.8

3.2.3 Protein Content

The application of protein content analyses conducted on food products will benefit greatly to those with dietary restrictions or those who just want to intake more protein for body health purpose. Therefore, the protein content was measured for the "Control," "Sample A," "Sample B," and the "Premium" samples in this proximate analysis experiment to indicate which sample possess the highest percentage of protein.

<div align="center">**Table 5.** Protein Content of the Samples.</div>

No	Samples	Protein Content (%)
1	Control	14.0
2	A (Stage 3)	9.6
3	B (Stage 5)	9.3
4	Premium	11.8

A notable reduction in protein content was observed in both BPP-containing samples. This is expected, as banana peel powder has significantly lower protein levels compared to wheat flour. Substituting 10% of wheat flour with BPP thus dilutes the protein density. The slight difference between Sample A and B (9.6% vs. 9.3%) may be due to increased sugar and moisture in the stage 5 sample, which contributes to dilution effects. Interestingly, the Premium sample's protein content was higher than that of A and B, likely because the activated charcoal had a neutral effect, preserving more of the wheat protein contribution.

3.2.4. Fat content

For people who are watching the amount of fat they consume in their diets, as well as for those who are looking for certain mouth-felt and flavour characteristics, the amount of fat contained in food products is an essential factor to consider and analysis. However, it is necessary to strike a balance between the fat level and the other nutritional components and to consider the context of the diet. During the course of this experiment involving proximate analysis, four samples were examined: Control, Sample A, Sample B, and Premium, each of which had their own unique fat content values.

<div align="center">**Table 6.** Fat Content of the Samples.</div>

No	Samples	Fat Content (%)
1	Control	0.6
2	A (Stage 3)	0.5
3	B (Stage 5)	0.6
4	Premium	1.2

Fat content remained relatively unchanged between control and BPP samples. Banana peel naturally contains very low-fat content, thus contributing little to the total lipid profile (Manzoor & Ahmad, 2021). However, the Premium sample exhibited double the fat content, possibly due to interaction with hydrophobic compounds in activated charcoal or absorption of residual oil during processing. The impact of ripening on fat content was negligible.

3.2.5. Carbohydrate content

One of the primary sources of energy in the human diet is carbohydrates. They provide glucose, the preferred fuel for cellular processes, to the body. Carbohydrates are also essential for regulating blood sugar levels, supporting cognitive function, and providing fibre. In this proximate analysis investigation, four samples were evaluated for their carbohydrate content which were Control, Sample A, Sample B, and Premium.

Table 7. Carbohydrate content of the samples.

No	Samples	Carbohydrate Content (%)
1	Control	74.0
2	A (Stage 3)	77.9
3	B (Stage 5)	77.8
4	Premium	72.3

The results indicate that the substitution of banana peel powder in both Sample A and Sample B led to a slight increase in carbohydrate content compared to the control sample. Both BPP-enriched samples showed a slight increase in carbohydrate content due to the residual sugars and non-digestible fibers present in banana peels (Grigelmo-Miguel *et al.*, 1999). The minimal difference between Sample A and B suggests that while Stage 5 contains more sugars, the total carbohydrate effect after drying is relatively consistent. The Premium sample's lower carbohydrate content may be attributed to the presence of activated charcoal, which does not contribute to any digestible carbohydrate. Overall, the incorporation of banana peel powder does not significantly compromise carbohydrate availability and may enhance the nutritional value of the noodles by providing functional carbohydrates in the form of fiber.

3.2.6. Dietary fiber content

Dietary fibre is a form of carbohydrate that the human body is unable to break down and use for energy. Nevertheless, it is an extremely important factor in the preservation of digestive health, the promotion of regular bowel movements, and the contribution to general well-being. In addition, the consumption of dietary fibre has been linked to numerous health benefits, such as the control of blood sugar levels, the management of excess body fat, and a decreased chance of developing certain diseases, such as coronary heart disease and colon cancer. In this experiment involving proximate analysis, four samples were investigated, namely Control, Sample A, Sample B, and Premium, with particular attention paid to the amount of dietary fibre each contained.

Table 8. Dietary Fiber Content of The Samples.

No	Samples	Dietary Fiber Content (%)
1	Control	0.1
2	A (Stage 3)	4.5
3	B (Stage 5)	4.6
4	Premium	3.8

The incorporation of BPP resulted in a substantial increase in fiber, confirming its functional potential. Sample B slightly exceeded Sample A, consistent with prior studies indicating that riper banana peels have a more soluble fiber fraction due to enzymatic modification during ripening (Emaga *et al.*, 2007). Soluble fibers can increase water-binding capacity and affect dough structure positively. Though Premium noodles did not contain banana peel, the activated charcoal may have contributed some indigestible material, explaining the elevated fiber relative to control.

4. Conclusions

This study demonstrated the potential of incorporating banana peel powder (BPP) from *pisang nangka* at different ripeness stages into air-dried instant noodles to enhance their nutritional quality. The results showed that both Stage 3 and Stage 5 BPP significantly increased dietary fiber and mineral (ash) content, while slightly reducing protein content due to wheat flour substitution. Stage 5 BPP produced noodles with higher moisture and fiber content, likely due to enzymatic changes during ripening that enhance water retention and solubility.

In addition to meeting the nutritional objective of enhancing fiber content, this study also highlights the potential for commercial application of banana peel powder (BPP) in the development of functional food products. The successful incorporation of BPP into a commonly consumed product like instant noodles demonstrates its viability for large-scale food manufacturing, especially in addressing rising consumer demand for healthier, fiber-rich options. However, for widespread acceptance, consumer education will play a critical role. Public perception of banana peel as a food ingredient may require targeted awareness campaigns to emphasize its nutritional benefits, sustainability impact, and safety. Collaborations between food producers, nutritionists, and public health agencies can help shift consumer attitudes and drive interest in upcycled food ingredients like BPP. Future research could also explore sensory optimization, labeling strategies, and market feasibility studies to support commercial readiness.

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